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THE RELATION BETWEEN SCIENCE AND THEOLOGY

HOW TO THINK ABOUT IT

BY

C. STUART GAGER

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To the memory of

MY FATHER

CHARLES CARROLL GAGER

Of all human ambitions, an open mind eagerly expectant of new discoveries and ready to remold convictions in the light of added knowledge and dispelled ignorances and misapprehensions, is the noblest, the rarest and the most difficult to achieve.

—James Harvey Robinson.

FOREWORD

THIS LITTLE BROCHURE embodies the substance of a lecture which has been given many times before various organizations, and the decision to offer it in printed form to a wider audience, is the result of repeated suggestions to that effect from those who have heard the lecture.

The lecture, and now the book, were not prepared for professional scientists nor theologians, but for laymen who may be interested to know something of the mental attitude of scientific men, and something of the method of thought and work by which scientists conduct their investigations and arrive at their results. In particular, it is intended for those who would welcome some constructive suggestion as to how they should order their own thinking concerning this important question of science and religion.

July 23, 1924. C. S. G.

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The Relation Between Science and Theology

"Let us work and think properly;
therein lie both principle and morality."
—PASCAL.

WHERE SHALL WE LOOK FOR KNOWLEDGE?

"IF WE leave it to the evolutionists to find out where we came from and to the theologians to find out where we are going to, we still have left the undeniable fact that we are here." With these words, T. DeWitt Talmadge, a well-known preacher of the 1890's, began a lecture which the writer heard when a boy. They contain two very valuable suggestions: first, that there is always a best source for knowledge of a given kind; and, second, that an understanding of the world in which we live is a challenge to every one of us.

In certain circumstances in life men act as if the first suggestion were an axiom, understood by all. Only an ignoramus, for example, would ever seek legal advice of a doctor, medical advice of a teacher, or religious advice of an infidel; and yet, when it comes to seeking an understanding of the material world about us—scientific advice—large numbers of men in all ages, now and hitherto, have turned, not to the scientist—the man who has studied nature at first hand and spent a lifetime of earnest endeavor to explain and understand her, but to the theologian, whose studies have been with the spiritual rather than with the material world.

At first thought it seems strange that men should so generally and so habitually do this but the reason is not far to seek. In the first place, in earlier times education was largely in the hands of the priesthood (whatever the religion), and the school was an appendage of the church. At certain periods it was even considered unworthy of the dignity of man to study *things;* ideas were all important, the foundations on which they were based were not too carefully inquired into, especially ideas about nature. The main thing was that such ideas should be in harmony with what men had hitherto thought and taught, and should square with religious prejudices or pre-judgments. The modern idea that, "The new facts should come from nature—fresh, buoyant, exact" (as stated by Agassiz) was almost unheard of or at least unheeded. Even Aristotle, one of the greatest intellects of all time, while recogniz-

ing that observation was important, placed much greater emphasis on speculating as to what ought to be. Long before Aristotle, Socrates taught that certain studies of nature were impious, regarding such study as intruding into the handiwork of the gods. In the early years of Christianity the end of the world was believed to be near and therefore it was considered a waste of time to study nature—all of which was so soon to be utterly destroyed.

Moreover, religion developed ages before science, and the sacred writings of all religions contain allusions to and explanations of the world of matter in harmony with contemporary ideas. These were the ideas of the intelligentsia, to be sure, but not of intelligentsia educated in science, for there was no science, in the modern sense of the term, when the world's great "bibles" were composed.

By an easy transition a reverence for the subjects primarily dealt with in these religious books (the sacred spiritual experiences of men) was transferred to the books themselves, and thus every statement they contained came ultimately to be considered as a statement of fact, equally valid with every other statement, and the books, *in toto*, were regarded as the final authority on every subject to which they referred, scientific as well as religious. "Greater is the authority of scripture," said St. Augustine, "than all the powers of the human mind. Nothing is to be accepted save on the authority of scripture." Reverence for the Bible was finally extended to include even the typography

when Voetius, a Dutch professor in the University of Utrecht, insisted that not only every word but the very punctuation marks were inspired of God, and this notwithstanding the fact that there existed, even then, numerous versions in various languages which differed in their wording as well as in the punctuation. This reverence for the books (amounting in some cases almost to worship) was only enhanced by the belief that their writers had a special divine revelation.[1] All thought that these religious writings were literature, to be interpreted like any literature, was banished from all minds; fiction and poetry were given the same interpretation and the same weight as the obviously historical portions, and if explanations and interpretations of natural phenomena did not square with the plain evidence of our senses then, we were told, so much the worse for the phenomena—and for our senses.

Thus men came to look to sacred writings and to religious teachers for information and guidance in matters scientific as well as religious. This attitude of mind, held so generally and with such reverence if not superstition, became one of the greatest obstacles to the development of a rational study and explanation of the material world, and even of the

[1] From the fact that St. Paul states that men are made to live on the "face of the earth," and in other places speaks of the earth as a tabernacle, it was held that there could be no "antipodes"— that is, the earth could not be globular; it was a parallelogram for that was the shape of the tabernacle! That the earth always casts a circular shadow (like every globe), or that men have sailed around it—such facts of observation counted for nothing as evidence; they were only a mark of impiety.

Bible. Preconceived ideas with the sanction and authority of religion, occupied men's minds so fully that contradictory ideas of things as they are could only with the greatest difficulty find an entrance.

Moreover, students of the material world (now called *scientists*[2]), however convinced in their own minds of the correctness of their observations, had the greatest hesitancy or even fear in publishing their results at variance with statements in sacred writings or even with ideas current in theological circles. And justifiably so, for to do this might mean banishment, or humiliating or perjuring recantation, or even torture and death.

Thus, in 1278, Roger Bacon, a forerunner of modern science, aroused ecclesiastical opposition by performing scientific experiments and advocating the experimental method in studying nature, and for this he was imprisoned for fourteen years (until the age of eighty). The charges against him were sorcery and "dangerous novelties"— in modern phraseology, *modernism.*

Galileo, for teaching the Copernican doctrine that the sun, and not the earth, is the center of the solar system, and that the earth revolves about the sun, not *vice versa,* was publicly insulted by a Bishop of the Church, was deprived of his salary as professor

[2] Huxley and other scientific men have strenuously objected to the use of the word *science,* unqualified, as referring to the study and knowledge of nature. Science and knowledge were, to a certain extent, synonyms, and a knowledge of nature was no more "science" than a knowledge of, for example, history; it was *natural* science. But the word has now come to be used generally as referring almost exclusively to a knowledge of nature, or to a *method of studying* phenomena of all kinds.

at the University of Pisa, and compelled, in 1632, to pronounce in public this recantation:

"I, Galileo, being in my seventieth year, being a prisoner and on my knees and before your Eminence, having before my eyes the Holy Gospel, which I touch with my hands, abjure, curse, and detest the error and the heresy of the movement of the earth."

Even after that he was exiled from friends and family, threatened with a dungeon, denied burial in his family tomb, and his friends were denied permission to erect a monument to his memory. He lived to see every university and school forbidden to teach what now every schoolboy knows as fact. Opposition to his doctrine came from both Catholics and Protestants.

Copernicus himself, who conceived the heliocentric theory as early as 1500, did not dare announce it until as late as 1543, when his great work, *Revolutions of the Heavenly Bodies*, was published, the author being then on his death bed. By so narrow a margin did the world miss the announcement of one of the most illuminating and pregnant ideas ever elaborated by the mind of man; and all because of ecclesiastical opposition to new scientific ideas—to what was then "modernism."

Whenever this classic conflict between science and theology is mentioned it should not be forgotten that the opposition was not confined to the Roman Catholic branch of Christianity. Luther and Melanchthon opposed the teachings of Copern-

cus; Calvin condemned him, citing from the first verse of the Ninety-third Psalm ("the world also is stablished, that it cannot be moved"); and John Wesley stated that the idea tended toward infidelity. Nor has theological opposition to science been confined to Christianity. Three hundred years before Christ the Greek philosopher, Aristarchus, was charged with blasphemy for teaching that the earth and planets moved around the sun.

If we wish to know *how* to think about the question of any possible conflict between science and theology we must keep in mind that the question must be viewed in perspective, and such historical facts as these are profoundly enlightening. It would seem as though anyone who, in the twentieth century, felt disposed to refute the results of a scientific study of nature by quoting texts of scripture would be given a little pause if he were familiar with this history. How instructive it is to see the same kind of opposition from the same sources arrayed against the methods and results of modern science today. It would seem that this is the inevitable result when theology presumes to sit in judgment on matters of science, or science to sit in judgment on matters of theology. We recall in this connection the statement of the Yale professor, that the greatest lesson he had learned as the result of thirty years of teaching undergraduates was that the human mind has infinite capacities for resisting the introduction of wisdom.

What a long, and painful, and sad struggle it has been for men to reach the stage where they recognize the reasonableness of leaving it to the theologians "to find out where we are going to" (and matters related thereto), but of depending for their knowledge of the material universe upon those whose lives have been devoted to studying it. Except in a few isolated quarters where superstition and bigotry still reign supreme, it is now generally recognized that the world's greatest students of nature have prosecuted their studies with devotion to truth, often with the sacrifice of money, of reputation, and of friends, and in a spirit as sincere and reverent as ever marked the theological studies of the cloister.

Lawyers for law, doctors for medicine, teachers for instruction, merchants for business, bankers for finance, engineers for engineering, theologians for theology, and—scientists for science. Does it not seem strange that anyone should now, in this age of the world, question the sweet reasonableness of this index to the proper sources of knowledge? We shall return to the enigma later on.

FUNDAMENTAL FACTS

BUT, questions of origin and destiny aside, said the preacher," we still have left the undeniable fact that we are here." And, being here, what are our obligations? They are numerous and in various realms—physical, intellectual, social, moral, and religious. One of our obligations is to endeavor to adjust ourselves to the world about us. This is necessary for our physical and spiritual well-being. Herbert Spencer defined life as "the continuous adjustment of internal relations to external relations." Clearly we must understand these relations if we are to make any approach to adequate adjustment. Since the dawn of history men have been endeavoring to solve the riddle of the universe, but progress has been painfully slow. One of the reasons for this has been the lack of an adequate *method* of study and thought, but among the results of this study are the following general truths or fundamental facts.

1.
Cause and Effect

It seems to be a necessity of our thinking to consider that nothing occurs without an adequate cause. Formerly, events were regarded as "causally" re-

lated to both the past and the future. There was the *efficient cause,* that produced the event, and the *final cause*—the purpose or object of the event. If a prolonged drought caused the failure of the crops it was understood that it might have been brought about for that purpose; if the moon gives light at night it must have been made for that. To be sure there are many nights when we are deprived of moonlight, but primitive man was not too presumptuous—not impious; he did not press such questions too far. But the object or purpose served by an event was considered as much its "cause," as the antecedent circumstances which gave rise to it.

In the infancy of the contemplation of nature men "jumped at conclusions," so to speak, assigning efficient or producing causes for natural phenomena without an adequate study of the facts—without, indeed, understanding *how* to study the facts. The problem was too big to be stated and solved early in the intellectual development of mankind. Furthermore, there was an almost insuperable obstacle in the way of this, as we shall shortly see.

2.
Secondary Causes

The causes of each individual event are called secondary causes, to distinguish them from the primary cause of all events. This distinction or differentiation was doubtless not thus clearly stated in the dawn of thought, but it will be convenient from

now on to refer to these two categories, and this can be done most conveniently by using their names, as here defined.

And, strange as it may seem, religion and theology—the contemplation of things unseen, arrested the interest of men before they became interested in understanding the material world about them and, when the study of nature began, theological habits and methods of thought were followed. Men looked within for an explanation of things without. Now, gods cannot be seen, and therefore theology affords poor training in observation. The history of thought clearly shows that it did not readily occur to the theologically-minded and theologically-trained thinker to observe first and reason afterwards; reasoning alone was considered sufficient. The existence of a god or gods is (rightfully) an axiom in religion. The gods are back of everything, was the primitive reasoning. Primitive man recognized that his own actions resulted from an act of will and were dictated by his knowledge and his desires. By an easy and natural transition he inferred that the phenomena of the inanimate world proceeded from similar causes.

What is the cause of the wind? Why, *obviously*, gods. Aeolus was god of storm and winds. Boreas of the north wind, Zephyros of the west wind, Eurus of the east wind, and Notus of the south wind. Neptune ruled the ocean, Ceres the crops. Thunderbolts were manufactured by Vulcan, and so on through the fascinating but not over-instruc-

tive mythology of the ancients The names of the gods differ with different nations and in different ages, but the idea is the same; the causes of things are the gods.

Gradually, however, a rational (as distinguished from a fanciful or unreasoned) explanation began to be formulated. Doubtless, observation began to be practiced and made the basis of reasoning. Instead of the wind being caused by the movement of the branches of trees (which, in turn, was caused by "Dryope's lone lulling of her child" [3]), it was recognized that the movement of the branches was "caused" by the wind. Instances could be multiplied illustrating the gradual transition from the "theological" to the "scientific" interpretation of nature.

Meaning of Cause.—But what do we mean by cause? The German word for cause is illuminating here: *Ursache*, which means an antecedent or *parental fact.*[4] We have gradually come to recognize that facts occur in series or in succession, and that certain occurrences are so related to other occurrences that when one takes place it has always and invariably been preceded by another and is always followed by a third. But as to what the mechanism is

[3] Dryope, having plucked a lotus flower to please her son, noticed drops of blood dripping from the stem. Wondering at the sight she turned to flee, but found she was rooted to the spot. Her body became the trunk of a tree, and her arms, outstretched to implore aid, became twisted branches. One of her last prayers was that her son might frequently play in the shade of her branches.

[4] *Urvater* means grandfather. Perhaps we might not inappropriately translate *die Ursache* as "the grandfather fact."

by which this is brought about we are often wholly or partially ignorant. A book, unsupported, falls to the ground. We are accustomed to say that gravity pulls it to the ground. There is no evidence, however, that gravity is a pull; for all we know, it may be a push from behind. In fact, this latter explanation has been seriously proposed by physicists as having some foundation in fact.

Of Explanation.—When, therefore, we think we have "explained" natural phenomena by ascertaining their "causes," we have, in reality, only recognized the order of sequence of events. This is only a more accurate description of the phenomena, and so "explanation" is, in reality, chiefly accurate description. This, in fact, is *the fundamental problem of science*—to describe natural events and their sequence as accurately as possible. When we have done this we should not deceive ourselves into thinking we understand the real nature of cause. Every scientist is aware of this limitation.[5]

3.
A Great First Cause

It was inevitable that the developing mind of early man should soon come to feel, not only that every individual must have an explanation in some

[5] *Cause* should not be confused with the *occasion* of an event. The officer's command is the occasion of the company halting, but not the cause of it. In scientific work it is not always easy to describe events in correct sequence. There is the same difficulty as was experienced by the little boy who said to his father, "Why is it that, when the parade stops, the captain always hollers halt?"

antecedent "cause," but that the sum-total of events —nature as a whole—must also have a great, powerful, First Cause—one "far off divine event." To postulate a great First Cause seems also to be a necessity of human thinking. We cannot understand an event uncaused; so also it seems difficult, if not impossible, to understand the universe as uncaused, hence the conception of "secondary causes" and a great First Cause of all things.

To trace any particular event back in unbroken sequence, step by step, to the great First Cause is obviously beyond human possibility. That is, it is impossible to do this by the same method of thought we employ in all scientific study, which is based on observation. To go back step by step to "the beginning" is a fascinating thought, but wholly beyond the range of possibility, except in imagination. One must, therefore, arrive at the idea of God by an extension of the idea of cause; it seems to be the most logical, if not the only logical inference from the sum-total of human experience. The heavens declare, not only "the glory of God," but His very existence.[6]

Whether "secondary causes" or the ultimate

[6] We are speaking here only from the standpoint of natural science. There are, of course, other human experiences with which science does not deal—religious or "spiritual" experiences—which lead men to postulate God. He is (for most men, at least) a necessity of the religious emotions, as well as of thinking. It has also been argued that the conception of God is an "innate idea." Many books have been written on the question of the origin and development of the idea of God. It is a fascinating but by no means a simple problem, nor is it one on which all thinkers—not even all theologians—agree.

First Cause were first conceived by the human mind is an historical question which need not concern us here. We only seek to point out that the mind of man has formulated both ideas—one as a matter of experience, the other, apparently, as a matter of intellectual necessity, also growing out of experience. It may also be noted that the natural and physical sciences (biology, physics, chemistry, geology, astronomy, and others) deal only with "secondary causes" and the phenomena they produce, while theology and religion are concerned only with the great First Cause—two fairly, but not absolutely, distinct realms of thought.

4.
Evolution

Recent discussions in the secular and religious press show that no word in common use is probably more generally misunderstood than the word evolution. Perhaps the commonest and largest error is to use it as synonymous with "the origin of species," or with "Darwinism," or with the bizarre idea that "men came from monkeys." The conception of evolution is a direct and logical deduction from the conception of cause and effect. "Cause and effect" implies, of course, that events are taking place. That events are causally related to each other implies an orderly and rational sequence. A continuous sequence of events, of necessity, implies change. Whatever the configuration of the universe at any

given moment, a change, however small, produces a new configuration—the picture is altered.

Experience tells us that changes are now taking place, not only in orderly sequence but *gradually*—that is, compared to the unimaginable stretches of geologic and astronomic time. *This unceasing, gradual, and orderly sequence of events is evolution.* The result of evolution is gradual change. Evolution *is* gradual change. Perhaps the most concise definition of evolution is the following statement:

The universe is now what it is because it was something else just a moment ago.[7]

This statement should be memorized, for it states the very essence of the idea of evolution.

(a) *Evolution in Language.*—The underlying idea of evolution may well be illustrated outside the realm of natural science by tracing the gradual changes in form or meaning which any modern word has undergone during recorded history. In early times in Rome, for example, it was customary to write on tablets of wax with a pointed *stylus*. By a euphemism one who wrote well was said to have a good stylus. In time, this expression was transferred from the handwriting to the form of expression, and one who expressed himself well was said to have a good stylus. Eventually the word became Anglicised, and able writers are now said to have a good *style*.

[7] This form of statement is not wholly original with the author, but the source of it cannot now be recalled.

There are in London and other cities streets called *mews*. People living in these streets may have canaries or other birds, and these birds shed their feathers once a year. Doubtless few dwellers in mews realize that there is any connection between the name of their street and the molting of their bird; but such is the case. The original "mews," in London, are stables built on the site of the cages where the royal falcons were confined during the days of falconry. Here they changed their plumage, or *mewed*. The Latin word for change is *muto*, whence the French *muer*, and finally, by altered pronunciation and spelling, the English *mew*. In time the word mew came to be applied to any city stable, and eventually to any city enclosure or street lined by stables. We speak of these gradual changes as the *evolution* of the word *mew*, as applied to a street.

(b) *Evolution in Astronomy.*—Note that we use the word "universe" in the above definition, for the principle of evolution applies to the entire cosmos. In astronomy the stories of classic mythology and other fanciful ideas were the first attempts at "explanation." The stars in the constellation of the Pleiades represent fair maidens, daughters of Atlas, who with the help of Diana, were saved from the pursuing Orion by being changed into doves. In this form they flew into the sky where they were transformed into stars! This tale is beautiful poetry and has greatly enriched literature but, like most poetry, it is very poor science, and, with other sim-

ilar ideas it has doubtless contributed more or less to delay the arrival of an explanation based upon observed facts.

Note that such "explanations" as this are far removed from description based on painstaking observation. They are pure figments of the imagination. We have already called attention to the fact that description is the essence of "cause" as understood in modern science. As the result of observation ,aided by powerful telescopes, we now regard the Pleiades as a star cluster produced by the breaking up of a stellar nebula. The process has, in all probability, required many billions of years; that is, what we now observe is the result of gradual changes operating through tremendous stretches of time; the process has been one of evolution.

It is also interesting to note here that, in the mythologies and other primitive explanations, the mind of man seemed always to seek for causes not only *outside* of the objects to be explained, but in the form of a being or beings endowed with mind, will, and "supernatural" power. This tendency is still strong and general among men and is the most natural inference for beings accustomed to associate causation with acts of their own will directed by intelligence. To insist that this tendency is in the direction of error would indeed be a bold assertion without adequate foundation in fact. But as soon as the mind is content to rest in such an "explanation" the advancement of a knowledge of nature ceases; there is no longer any problem to solve.

(c) *Evolution in Geology.*—Previous to about 1800 it was generally believed that existing geological forms—continents and oceans, mountains and valleys, and other earth forms—had been produced by "cataclysms of nature." It was as if one were to say, "What a terrific cataclysm must have rent the earth asunder to form the Grand Canyon of the Colorado!" It was, no doubt, more natural for men to be impressed with earthquakes, volcanoes, and thunder, than with the steady but quiet flow of streams, the incessant beating of waves, the unceasing but noiseless weathering of rocks, and other less obtrusive processes.

But in 1781, James Hutton, a Scotsman, read a paper before the Royal Society of Edinburgh in which he called attention to the fact that the face of the earth had not only changed in the past, but was, at the present time, undergoing continual change, the continents being continually worn down toward sea-level by the agents of erosion, and continually elevated by forces resident in the earth's interior. He contended further that geologic forms (mountains, valleys, shore-lines, and other forms) have been produced chiefly by the operation of comparatively small and quiet processes operating through *enormous stretches of time.* The earth was not "rent asunder" to form canyons; they are formed by weathering and the incessant erosion of the streams that flow in them. Valleys were not made *for* streams, but *by* streams. Hutton further contended that the geological forces now operative

are, in all probability, the same forces that have been operative throughout geologic time; as valleys and mountains are formed now, so have they always been formed. Mountains have not been "thrown up" by some vast upheaval of the earth's crust, but have grown, so to speak, by almost, if not quite, imperceptible stages through successive geologic periods. If we find shore-lines now in continental interiors, far removed from wave action, there is but one conclusion—these shore-lines must, at some time in the past have bordered an ocean or an inland lake.[8]

Hutton's hypothesis was severely attacked as "hostile to sacred history . . . and to the dictates of rational philosophy." Now it is taught in every high school, not as hypothesis, but as fact. No one now dreams of contending that we are thereby teaching our youth to be irreligious, or substituting a principle for Deity. In 1802, Playfair, a pupil of Hutton, published his *Illustrations of the Huttonian Theory*, and finally, in 1830, appeared Lyell's epoch-making *Principles of Geology*, in which the Huttonian theory was extended and made the foundation of all subsequent study of geology. But, for giving to the world this book, which has been called "one of the landmarks in the advance of human thought"—for endeavoring to tell the truth as he saw it, and as anyone could observe it after it was

[8] The basins of Lake Bonneville and Lake Lahontan, in the western United States, are classic examples of this. Their ancient shore-lines were formed by the waves of inland seas that no longer exist, or of which only remnants remain.

once pointed out, the author, Sir Charles Lyell, met with bitter attacks from ministers of the gospel, and for a period suffered social ostracism.

This history of our modern ideas in geology illustrates well the common history of scientific ideas, as stated by Agassiz: first, men say they are not true; second, they are declared in conflict with religion; third, they are generally accepted, and it is often declared that they have always been known.

(d) *Evolution in Chemistry.*—The application of the idea of evolution to the realm of chemistry was foreshadowed as early as 1815 when Prout, a noted chemist of that period, pointed out that certain facts of chemistry suggested that the atoms of the different elements were formed by condensation of atoms of hydrogen, hydrogen being the "ancestor," so to speak, of all other elements which were thus *evolved* in accordance with natural laws. Prout's hypothesis has not been confirmed, but recent studies indicate that the atoms of every substance have a nucleus about which electrons (unit charges of negative electricity) revolve in orbits. The nucleus bears a positive charge, and is, in all cases, an atom of helium. It was not until the present century that the discovery of radioactivity (and earlier of X-rays) made it possible to demonstrate experimentally that certain elements (having lighter atoms) are derived from other elements (having heavier atoms), and that the process may be observed and demonstrated in our laboratories.

(e) *Evolution in Biology.*—The discussion of this subject brings us at once to a consideration of our fifth Fundamental Truth.

5.
Biogenesis

The Origin of Life.—What was the origin of life? It has been suggested that the first living matter on the earth came from some other planet, carried possibly by a meteor. It would be difficult, if not impossible, to disprove this, for it is never possible to prove a universal negative.[9] All we can say is that from what we know of the nature and condition of meteors (heated to incandescence by the time they reach the surface of the earth), from the lack of evidence of the possibility of life on other heavenly bodies, and from all the other known evidence there is no reason, based on fact, for thinking that life first appeared on the earth in any such manner. We are left with two alternatives: first, the primitive idea that a god (or God) "created" life, the implication of "creation" usually being that the process was supernatural, or irrelevant, or unknowable, or that it is impious or idle to inquire into it; second, that living matter was produced from non-living matter *by the operation of natural forces inherent in matter.*

[9] For example, one blue rose would be amply sufficient to prove that a blue rose is a possibility, but the fact that no one has ever seen a blue rose proves nothing as to the possibility of producing a rose of that color. A red sunflower would have seemed highly improbable twenty years ago; now the seeds of red sunflowers may be purchased of seedsmen.

In the latter case two views are possible: either a great First Cause was operative, using natural forces to accomplish a preconceived result, or the result was brought about solely by the operation of "secondary" causes. In our thinking we may include God or not. And right here is where science and theology (not religion) part company, for if we are *content* to say *merely,* "God made it," there is an end to all further inquiry; the problem is solved. But *the essence of science is problem-solving.* The scientist may or may not *believe* that a deity was involved, but whichever way he *believes,* the problem still remains to challenge and interest him, and urge him on to investigation: How—*by what sequence of events*—was the result accomplished? Or, if one prefers, How did God work in accomplishing this result? To quote the Bible, the first of the above attitudes is expressed by the words of Zophar to Job,[10] "Canst thou by searching find out God?" And so one doesn't search—and doesn't find. The second man—the scientist—is continually urged to inquiry in the spirit of the Sermon on the Mount, "Seek, and ye shall find . . . and he that seeketh findeth." [11]

Let it now be emphasized that we have not said that the scientist must or does reject God. What we have said is that, whether he accepts or rejects, he recognizes that he is still confronted with an unsolved problem that fascinates him, and he devotes

[10] *Job,* xi, 7.

[11] *Matthew,* vii, 7 and 8.

his life to an endeavor to solve such problems. It is this that makes him a scientist. The problems of natural science have to do with "secondary" causes; theology has to do with the great First Cause. La Place was quite right in his reply to Napoleon. He presented the Emperor with a copy of this wonderful book, *Mécanique céleste*. Napoleon remarked that he found no mention of God in its pages. "Sir," was the reply, "I had no need of that hypothesis." The book dealt with "secondary" causes. One might as appropriately have found fault with Euclid for omitting all reference to God from his *Geometry*. La Place might have been, and in fact was, a devout Christian, but he was endeavoring to describe a portion of the world of matter.

But, however life may have *originated* on the earth, one fact is certain—we know of only one way by which living things *now* originate, and that is from living parents. The extension of this truth from man and the higher animals and plants to all forms of life, including micro-organisms or "germs," was the result of the most laborious and sustained investigations carried on in the face of long-intrenched prejudice to the contrary, and against active opposition. But the experiments were made by various men in different countries. The outstanding names are—Redi in Italy, Pasteur in France, Tyndal in England. They used different methods, but their findings were in entire harmony. Their published results are a part of the literature of science, available in every college library, and,

most important of all, their experiments may be repeated by anyone with proper training and skill. They have been repeated over and over again, and always with the same result. This result is tersely expressed by the Latin phrase, *Omne vivum e vivo* (All life from life). This is what we mean by *Biogenesis*.

Scope of Biology.—Here is where the science of Biology (the science of life) begins—with life. Ultimately, of course, there is the great unsolved mystery as to how life began on this planet, but the science of biology, as now understood and defined, has for its immediate problem *to describe* the world of living things—plants and animals, in the hope that this careful description will ultimately lead to understanding and explanation, and will make it possible to answer *the fundamental question*—What is life?

What Is Organic Evolution?—Organic evolution starts with life. The science of biology takes for granted the existence of living things—plants and animals. For the present the problem of the *origin* of life is kept more or less in the background, and students of biology are now, as they have always been, occupied with *describing* the forms and activities of living things. In fact, biology was formerly called a descriptive science, in contrast to physics and chemistry, which were called experimental sciences. However, experimentation has now become an essential part of the method of studying living things; but an experiment is largely a device which

enables us to observe and describe to greater advantage.

Reproduction.—Every living thing begins life, gradually, reaches maturity, grows old, and dies. No living thing—microbe or man—is the same at any two consecutive moments. Also, in the course of its own life history, there is a period when it is normal for every living thing to reproduce other living things. As we have seen above, this is the only known method by which living things can come into existence. Reproduction would appear to be a necessity for every individual—plant or animal.

Inheritance.—For the most part, offspring resemble their parents but, whether the resemblance is greater or less, every "child" (plant or animal offspring) receives from its parent or parents *something to start with.* This something is a tiny speck of living matter (protoplasm), a plant or animal *cell*, having a very definite and characteristic composition and structure. *This living matter or cell is the inheritance.* The case is quite analogous to the inheritance of property. A son may inherit the parental estate—a certain parcel of land, with the vegetation, animal life, and buildings. As years go by, the son may cut down certain trees, add others, stock the streams with new kinds of fish, see that undesirable animals are killed or driven off, build new buildings, or remodel or tear down old ones. In the course of a few years the estate may resemble the property as it was received from the parent or it may hardly resemble it at all. But whether it

finally resembles the original estate *or not,* the fact of inheritance is not altered. *That which was inherited was what the heir had to start with.* This is the fundamental fact about inheritance—it is all that an organism has to start with.

Expression.—Inheritance is often defined as resemblance, or as "the tendency of offspring to resemble their parents." The fact is, however, that we do not directly inherit our stature, nor the color of our eyes, nor the shape of our nose. What we inherit is a tiny bit of protoplasm—the egg from which all living things derive; as we mature, the *expression* of our inheritance may or *may not* resemble that of our parents.

Inheritance is thus seen to have a physical basis in the fertilized egg. The factors—the *genes* (producers) they are commonly called—are now generally believed to reside in certain characteristic bodies, the *chromosomes,* which appear in the nucleus of every cell at a certain stage of its life history. Any change in the composition or number of the chromosomes affects the inheritance and therefore the expression.

But the expression is not a function of the inheritance alone—it is the product of the inheritance and the environment *acting together.* A seed from a willow, planted well above the timber line on a mountain, will never become more than a tiny shrub, a few inches high. The same seed, or another from the same tree, planted by a stream on the lowlands at the base of the mountain will, barring accidents,

become a tall tree like the one from which it came. The inheritance is the same, but a different environment produces a different expression.

We are all familiar with the change in expression that accompanies a change in environment as, for example, when the polar bear changes his dark summer coat for his white one of winter. It has been experimentally established that the plumage of birds can be profoundly modified merely by subjecting the birds, while maturing or while moulting, to different degrees of temperature. Everyone is familiar with the yellowish or greenish spot on one side of a red apple where the skin was protected from direct sunlight as the fruit matured. Only the environment of the surface was changed; the inheritance was not altered.

Variation.—Careful observation of living things has disclosed the fact that no two individuals, even of the same species, are precisely alike. "Identical" twins have some unlike characteristics. It is almost, if not quite, certain that there never existed two leaves of a sugar maple (or of any other tree) that would exactly coincide if placed one upon the other. While it is true that men never gather grapes of thorns nor figs of thistles, it is equally true that Ephraim Bull, of Concord, Massachusetts, did, in 1849, gather a branch of luscious "Concord" grapes from a seedling "sport" descended from a small-fruited species of a wild grapevine. All the thousands of Concord grapevines since cultivated in vineyards have been propagated as cuttings from

the original Concord vine. It is also true that the numerous varieties of commercial figs were derived under cultivation (and therefore under observation) from wild figs. From such facts as these and from a mass of other evidence, we realize that inheritance and variation go "hand in hand." It is probable, if not certain, that, in higher plants and animals at least, no offspring ever absolutely resembled its parents.

Struggle and Survival.—As the saying is, "every schoolboy now knows" that more individuals of a given species are produced annually than there are room and food for. Malthus called attention to this in the case of man. Darwin, reading Malthus, extended the idea to the entire world of living things. The result of this condition is a "struggle for existence," and those best fitted to succeed in the given environment ("the fittest") are most likely to survive.[12] As we are not now attempting to write a treatise on organic evolution, this thought cannot here be enlarged upon. Biological literature during the past fifty years or more has been full of illustrations among both plants and animals. The decisive victory of weeds in any field of cultivated plants left to itself tells the whole story, and is well-known to everyone.

New Types.—In the struggle for existence it often happens that those individuals that, by variation, depart in one way or another from their par-

[12] The phrase "survival of the fittest" is terse and catching, but it is not always the fittest alone that survive; the survivors include all of those not too unfit to succeed or survive.

ents are best fitted to succeed in the given environment, and so they survive while the others perish. To the thoughtful reader it hardly needs to be pointed out that the end result of such a process will be the disappearance of an old type (at least locally), and the appearance of a new one. New types are sometimes called varieties (e. g., the horticultural varieties of apples); but often they become so clearly defined from the original stock that they are called species. Scientists may, and often do, differ among themselves as to whether a given organism represents a distinct species or only a variety. Owing to difference in judgment between authors, or even to a change of judgment in the same author, there are many forms of plants that have appeared in an earlier edition of a manual of botany as varieties, only, in subsequent editions, to be elevated to the rank of a species.

Origin of the Fittest.—While we speak of the "survival of the fittest," we must remember that what takes place in nature is the weeding out or rejection of the unfit; they perish, leaving, as survivors, those adapted in greater or lesser degree to the conditions of environment. But what of the *origin* of the fittest? Struggle and survival produce nothing new; they only act as a sieve, retaining the better adapted organisms to perpetuate the race. Before "the fittest" can struggle and survive it must first exist. This introduces us to one of the darker corners of evolution. Biologists wish they *knew* how "the fit" originate. The Dutch bot-

anist, de Vries, has adduced a mass of evidence indicating that only discontinuous variations or *mutations* supply the material for natural selection. Mutations are qualitative changes that are preserved by inheritance, as contrasted to quantitative changes (continuous variations or fluctuations) that are inherited only imperfectly if at all. But the evidence that mutation is the key to the origin of the fittest is not sufficient to lead all investigators to accept the mutation theory as an adequate explanation of the origin of the variations that survive in the struggle for existence. There is not the slightest disagreement among students as to the *fact* of organic evolution, but only as to the *method* by which new species evolve.

What Is a Species?—From the preceding paragraphs we see that a species is, to a certain extent, a matter of definition. The first (1848) edition of Gray's *Manual of Botany,* for example, recognized in the northeastern United States only seven species of the Hawthorn (*Crataegus*); in the seventh (1908) edition, sixty-five species are recognized in the same range. The increase in the number of species resulted, in part, from the study of new material, but also, in part, from the restudying of the old material by botanists who were more impressed with differences and their importance than with resemblances and their importance. The result was the great multiplication of species.

How are Species Made?—It is said that when someone once asked the noted botanist, Asa Gray,

if he believed that God "created" species, he replied, "I know he didn't; I have created too many myself!" Such a statement would seem irreverent to one who did not understand just what the term species connotes to a botanist or a zoologist. Without unduly elaborating, we may briefly note here that "Nature" (God operating by natural laws) creates *individuals* (with their variations); species are made by man. A species, in other words, is a concept. It is not *merely* a concept. No one, for example, would ever confuse a domestic cat with a tiger, a cow with a buffalo, a pear with an apple. Here the concept of the species has an objective correspondence in reality that would not confuse even a layman in science. But there are thousands of cases where the distinction is not so clearly drawn in the organisms themselves, and therefore where opinions differ, even among professional biologists equally competent to judge.

From such considerations as these we see how idle it was ever to have raised the question as to whether "species" were "created" in the beginning; how idle it is to discuss it now. The question has little importance to one who understands the terms used. How much more idle was it, ever to have associated such a question with theological and religious matters. How reasonable it is to leave it to the evolutionists to find out where we came from and to the theologians to find out where we are going to.

What Is Darwinism?—From what has gone before we are now in a position to appreciate the

statement that a species is not an individual but a homogeneous *group of individuals,* resembling each other so closely that they might, reasonably enough, have come from the same parents. Of any individual plant or animal we should say that it *represents* this or that species. Now the theory that such a homogeneous group of individuals is the product of natural selection acting on favorable variations is Darwinism. We see how erroneous it is to use the term "Darwinism" as synonymous with the term evolution. Darwinism is only one of numerous attempts to describe in detail ("explain," if one likes) the method of origin of specific groups of living things. It takes for granted the *fact* of evolution, and was only offered as a tentative explanation of *the method* of organic evolution.

THE METHOD OF SCIENCE

FOLLOWING the publication of Darwin's *Origin of Species,* in 1859, there was begun one of the most bitter of all controversies between "science" and "theology"—really between scientists and theologians—between the champions of the new ideas and the champions of tradition. The battle was long-drawn-out, but there had been no signs of open conflict for some twenty-five or thirty years previous to the date of this little book. It had become not

uncommon for the fact of evolution to be taken for granted in Christian pulpits; with unimportant exceptions ministers of religion had ceased to villify Charles Darwin and his followers, and scientific men had come to feel that there was almost, if not quite, universal acceptance of what to them was undebatable fact—namely, the fact of organic evolution.

But within the past year or two a man gifted in oratory, but who had spent most of his life in active participation in politics, presumed to assume the rôle of authoritative interpreter of the Bible, as well as the rôle of critic of science and of scientists. By the force of his oratory and of his well-known name he gained the attention of popular audiences and finally of the legislatures in several states of the Union. The newspapers, always ready to report a fight of any kind, took up the matter and thus gave it wide publicity. To the genuine surprise of scientific men, it soon appeared that the champion of tradition and of early nineteenth century theology had quite a following. Apparently there was a considerable group only waiting for a leader. After the scientists were through rubbing their eyes in astonishment they began to realize that the theological-scientific battles of 1860-80 must, to a certain extent at least, be fought all over again.

What is the meaning of the reopening of this controversy? This, that whole sections of the people have, as yet, not the slightest comprehension of *how* science is studied, of what is meant by "scientific

method," of what the attitude of scientific men really is toward their work, nor of the results of scholarship—not only in natural science but in theology and the study of the Bible. *This is the great lesson of what, for the sake of brevity, may be called the Bryan controversy.* The writer is convinced that what is most needed now is not so much argument in behalf of the results of modern science, as a campaign of popular education as to *what are the aims and, in particular, the method of science.* If the recently-published controversial articles and the recently-reported controversial addresses teach us anything, it is that vast numbers of people have not the faintest conception of *how* to think on such matters. Libraries of books and articles have been printed on *what* to think, but almost nothing appears to have been accomplished in the line of teaching people *how* to think.

Whose fault is this? Largely that of the scientists and the teachers in our schools and colleges. Anyone familiar with biological text-books published during the past fifty years, and with the practices in laboratories and lecture rooms during the same period knows that attention and effort has been centered almost exclusively on the subject matter of the various sciences. The work of instruction has proceeded too largely on the supposition that "science" is synonymous with information; that science is *only* "organized common sense." The fact has been too largely overlooked that *science is a method of thought and work* as truly as it is a

body of information. Training in scientific method is the great desideratum. People are much more likely to have correct ideas if they understand and practice the correct method of ascertaining ideas. This matter of *method is the very essence and kernel of natural science.* This is the significance of the expression "scientific method" when applied in other lines of work—for example, the study of history or the organization and conduct of business.

ESSENTIALS OF SCIENTIFIC METHOD

WHAT, therefore, are the essentials of scientific method? How *must* one think on scientific matters if he wishes to know the truth? A book could be written on the subject, but in bare outline the main points of scientific method are as follows:

1. *An Open Mind.*—Many people never think; they only have prejudices. One might as well expect to get sunlight into a dark room with all the windows curtained as to illuminate his mind if it is closed to the external evidences of truth. One might as well expect to find his way among the streets of a strange city without reading the sign-posts or asking those who know the way, as to find his way among facts and ideas by consulting his inclinations and preferences rather than by mastering the evidence without pre-judging, or by consulting those who have produced and mastered this evidence—

those who have found the most *reasonable* way by employing the only rational method.

It has been said, with much reason, that no one ever changes his fundamental conceptions after the age of forty. By that time his ideas as well as his habits can be changed only with difficulty, if at all. When shoes for men were introduced into America the grandfathers largely continued to wear boots; when fountain pens and safety razors were first put on the market, the largest sales were to men under forty; it was a young man who broke away from the centuries-old idea that the earth was at the center of our system, unmoving; it was a man under thirty who said, "Ye have heard that it hath been said, Thou shalt love thy neighbor, and hate thine enemy. But I say unto you, Love your enemies, bless them that curse you, do good to them that hate you, and pray for them which despitefully use you, and persecute you." It was more difficult for "the elders" to understand this doctrine and incorporate it into their philosophy of life than it was for the young men who heard it.

The same teacher said that if we would enter into the kingdom of heaven we must become as little children. So it is that, if we would enter into the kingdom of knowledge we must become as little children in the matter of keeping our minds open to new evidences of truth. If it had not been for this quality of open-mindedness we should still be in the intellectual twilight of the dark ages. No idea is to be discarded *because* it is modern, but only

because it is advanced on insufficient or untrustworthy evidence. It is, of course, just as true that no idea is to be accepted *because* it is modern, unless it has an adequate and trustworthy foundation in fact or, in other words, is not founded on prejudice.

Nor does it matter much what we *want* to be true —what our preferences are. The notion of a flat immovable earth was fondly cherished by many at one time; it went against many men's wishes and inclinations to be told that the earth was a rotating, revolving globe; so it did to be told that the golden rule was the only correct guide to conduct. But in seeking the truth, preferences, prejudices, old ideas long cherished are of secondary consequence—or of no consequence at all. They are to be discarded just as sailboats were for steamers, or "one hoss shays" for automobiles. They have served a purpose—a good one maybe, but their usefulness is over in the light of the new knowledge.

Nor is the age of an idea a sure guide to its correctness. The conceptions of classical mythology and of a flat earth had endured for generations before they were discarded in the light of advancing knowledge. One of the most striking aspects of modern science is the discarding of ideas about matter and energy that had seemed to be the very foundation stones of "modern" science. The age of an idea is, therefore, no sure index that it is correct; it may only indicate how slowly our knowledge advances and how sluggishly we modify our ideas in the light of newly-discovered evidence.

2. *Toleration.*—All of this teaches us the reasonableness—the necessity even—of toleration. If older men cannot accept, readily and fully or at all, the ideas of a new generation let the new generation remember how difficult it is for one to discard old lamps of knowledge for new. If younger men cannot accept, unmodified, the conceptions of the preceding generation let their elders remember that the outstanding characteristic of knowledge is change. And how fortunate it is that this is so; otherwise we should now consider Eurus the cause of the east wind, and Vulcan the cause of thunder; radio and aviation would still be unknown—we should all be living in caves.

The pages of history contain many sad and humiliating instances of the extremes to which men have been led by intolerance. One of the most striking is the Anathema of Spinoza, passed by the Jews of the Portugese synagogue at Amsterdam, in 1666:

"By sentence of the angels, by the decree of the saints, we anathematise, cut off, curse, and execrate Baruch Spinoza, in the presence of these sacred books with the six hundred and thirteen precepts which are written therein, with the anathema wherewith Joshua anathematised Jericho; with the cursing wherewith Elisha cursed the children; and with all the cursings which are written in the book of the law; cursed be he by day, and cursed by night; cursed when he lieth down; cursed when he riseth up; cursed when he goeth out, and cursed when he goeth in; the Lord pardon him never; the wrath and

fury of the Lord burn upon this man, and bring upon him all the curses which are written in the Book of the Law. The Lord blot out his name under heaven. The Lord set him apart for destruction from all the tribes of Israel with all the curses of the firmament which are written in the Book of this Law. . . . There shall no man speak to him, no man write to him, no man show him any kindness, no man stay under the same roof with him, no man come nigh him."

And for what was this terrible penalty imposed? Why, Spinoza, one of the many glories of the Jewish race, a young man only twenty-three years old, decided that he would take his Bible, read it carefully, thoughtfully, reverently, and endeavor to reach honest and right opinions as to its meaning and teaching concerning God and religion. He was gifted intellectually and devoutly religious. The conclusions he reached were at variance with those generally accepted and taught by contemporary ecclesiastical authority, and this anathema was the penalty he paid for being honest and independent in his intellectual and religious life.

We of today can hardly understand the degree of intolerance expressed in this anathema, and yet the same spirit exists now. Manifestations of it in the recent but belated attempt to revive the "conflict between science and religion," have shocked and even startled us. Those who reopened the controversy have not hesitated to impugn with all manner of unworthy motives those who differ from

them on questions of biological science. Scientific men of high character—many of them profoundly religious—have been accused of attempting, not so much to advance our knowledge, as to undermine our religion. They have been accused of attempting deliberately to corrupt our youth, and bills have been introduced into the legislatures of several states making it a misdemeanor for anyone to teach what everyone acquainted with the facts at first hand knows to be true. More than one man with a family dependent upon him for support has been dismissed from his professorship and thereby caused financial loss and privation because he taught what his conscience told him was right and proper and what his brain told him was in accord with the findings of modern science.

Teachers have been dismissed from their positions in the Rhea County High School (Dayton, Tenn.), the University of Tennessee, Missouri Wesleyan College, Baylor University, Waco, Texas, and Mercer University, Macon, Georgia. The State Legislatures of Oklahoma and Tennessee have enacted laws prohibiting or restricting the teaching of evolution in schools supported by public money, and bills prohibiting such teaching failed to pass by only narrow margins in the state legislatures of North Carolina, Texas, and Kentucky (the latter by one vote, only). After the anti-evolution bill failed to pass in the legislature of North Carolina the State Board of Education, with the approval of the Governor of the State, banned the teaching of evolution

in the schools under its jurisdiction. The Regents of the State University of Texas, and the Legislature of Florida, have passed resolutions against employing teachers who favor evolution. In the Georgia Legislature an appropriation of money for the maintenance of the state library was voted down on the ground that there were books in the library on evolution. Such laws, as has recently been noted (*Outlook* for May, 27, 1925, p. 131), impose dogma upon the youth of the schools, and in their letter put a ban upon the age-long search for truth.

In illustration of these assertions, it may be noted that, according to newspaper reports (*e. g.,* N. Y. *Times*, March 17, 1924), the pastor of a large Baptist church in New York City has recently called one who teaches the theory of evolution a "traitor to God," and has referred to the hypothesis itself as "degrading." If we are to believe a news item in the New York *Times* for May 19, 1925, a former Secretary of State, who is a prominent member of the Presbyterian Church, in a public address in Brooklyn on May 18, 1925, spoke as follows: "Scientists think that the discovery of a fossil of a five-toed horse is a more important event than the birth of Christ. They will travel around the world to see a skeleton, but would not cross the street to save a soul." Almost identical language occurs in a letter, dated March 9, 1922, and signed by the same man, in the New York *Times* for March 14, 1922. In this letter the writer also asserts that scientific men "misrepresent their opponents," "evade the

issue which they pretend to discuss," and that, in so doing, they "have exhibited all the characteristics of their class." The name of the author of such untruths is not important. He appears to have a numerous following. The statements are cited merely as evidence that the same spirit which opposed Roger Bacon in 1278, Galileo in 1632, Copernicus in 1500, Lyell and Darwin in 1859, is still alive, and if those in whom it dwells could only gain sufficient power they would put an end to one of the most precious heritages of modern civilization, namely, freedom to seek and to proclaim the truth without fear of persecution, imprisonment, or death. This is a more important issue than the truth or falsity of any particular scientific hypothesis or theory.

It almost seems as though these self-appointed protagonists of "religion" were in a panic lest their religious opinions could not stand in the light of advancing knowledge. The lesson taught by all this wrangling is not only one of toleration, but the historic lesson of the final and eternal triumph of truth. Sometimes it has seemeed as though men were slow to perceive the truth; often they have seemed loath to receive it, especially when it clashed with long fondled prejudices; but the lesson of history is unmistakedly clear. The ultimate triumph of truth is always only a matter of time and the surest way to know the truth is to disseminate and exchange ideas in a spirit of toleration and of a real wish to know the truth whatever the consequences to our own pet ideas, or hopes.

3. *Recognition of the Uniformity of Nature.*—Perhaps no fact is more momentous than the uniformity of nature. Everyone realizes how necessary is steadfastness of character. One cannot deal with a man who is truthful today but lies tomorrow. Likewise it would be impossible for us to adjust ourselves to a capricious or whimsical world. But ours is a world of unvarying law. The sun does not rise in the east today and in the west tomorrow; fire *always* burns; unsupported objects *always* fall to the earth; poisonous substances are *always* poisonous; spring *always* follows winter; children *always* have parents; effects *always* follow causes.

Were it not for this unvarying uniformity we could not interpret the past, forecast (to even the slightest degree) the future, nor adjust ourselves to our environment. Health, happiness, commerce, science, education, life itself—all depend on the fact of the uniformity of nature.

The Unchangeableness of God.—How strange it is, for theologians in particular, ever to question this essential feature of scientific method—recognition of the uniformity of nature. For, however much they may disagree on other points, they seem to agree unanimously that God is in his world, that it is an expression of the Creator, and that he never changes. "I am the Lord, I change not";[13] "the Father of lights, with whom is no variableness, neither shadow of turning."[14] "Jesus Christ the

[13] Malachi iii, 6.
[14] James i, 17.

same yesterday, today, and forever." [15] If this attribute of God is correctly conceived (and how could it be otherwise?), how has God wrought hitherto, and how will he work in the future? *Obviously,* the key to the future and the past is the present.

It is hardly possible to exaggerate the importance of this truth, but it appears to be (and to have been) rather easy, under certain circumstances, to loose sight of it, so that men, in discussing certain problems, have stated their case so as to imply that God moves, not only "in a *mysterious* way His wonders to perform," but in a more or less capricious way, with great lack of uniformity as to motive and method. He is "the same yesterday, today and forever" in one connection, but fickle and uncertain in other connections. We shall revert to this later, but we wish here to emphasize the fact that uniformity (which means dependableness and steadfastness of character) marks the highest possible conception of God, and is the only conception in harmony with the material world, of which He is regarded by the theologian as the author or creator. Any attempted explanation of things not in harmony with this conception should be regarded with great suspicion and accepted with the greatest caution. It should, in fact, be accepted as only a tentative, inadequate explanation to be gladly discarded as soon as an explanation is formulated more closely

[15] Hebrews xiii, 8.

in harmony with the above and only rational conception of God.

But what bearing has all this on the question of the origin of man? Well, the only way by which men come into the world now is by birth from parents. If one prefers, the scientist surely has no objection to putting it this way: The only way known by which God now creates a human being is by birth from pre-existing parents. If God is the same yesterday, today, and forever, must we not believe that this is the way He has always produced human beings? Must not any account to the contrary be judged, as to its trustworthiness, on the basis of this criterion?

Is one embarrassed or disturbed by the question as to how the first man was born—as to what manner of parents he had? Well, such a question implies that the "first man" was a creature like the average man we nowadays meet on the street; otherwise there must have been an evolution (a gradual change) of modern man out of primitive man. But, if this thought—the notion of a gradual transformation of man—is distasteful, how are we to account for such different kinds of men as the pygmies of Africa, the stalwart Scandinavians, the negroes, the American Indians, and the Caucasians? Were the Hottentots made by God out of dust, as a *separate* "creation"? If so, what becomes of the hypothetical "first" man? Or do we, perhaps, err in calling Hottentots and Pygmies men? Certainly if we hold that there was a "first" man, and that the Pygmies,

giants, Hottentots, Negroes, Yellow races, and Caucasians are all men, we accept the operation of human evolution on a really stupendous scale. But is there anyone who questions for a moment that these various groups are all groups of *men?* Yet they differ from each other *anatomically* as well as intellectually and spiritually, as widely as innumerable groups of lower animals and plants that are recognized by all competent biologists as distinct species.

But these questions are not raised here as an argument in favor of organic evolution, but to illustrate *the kind of questions* one must ask and seek to answer if he wishes to arrive at a knowledge of the truth of this matter *by thinking* rather than by nursing certain preconceived notions and prejudices; for the purpose of this book, as stated in the beginning, is to indicate, not so much *what* to think, as *how* to think on these questions. And this leads to the next important point in scientific method.

4. *The Processes of Thought.*—Science is often thought of as a body of knowledge. It has been defined by Huxley as "organized common sense." From another point of view, and perhaps more fundamentally, as noted above, *the essence of science is method*—a method, or rather *the* method of obtaining knowledge. One who does not understand the method of science cannot intelligently understand, much less pass judgment, upon the results of the application of scientific method.

This method includes the employing of certain mental operations, and in a certain logical order. These operations are as follows:

Observation.—The fear of the Lord may be the beginning of wisdom, but *the beginning of knowledge is Observation.* And observation is much more than mere looking; it involves the use of both eyes and brain. It consists in reading meaning into what one sees. In looking one may be more or less passive; in observing he is active, looking for a purpose. The looker receives an image on the retina, possibly nothing more; the observer, confronted with a fact, puts to it definite questions and then seeks the answer to these questions, not from another person—an "authority"—but from the fact itself. He receives not only an image on the retina, but an idea in his mind. He who *looks* at the sky at night sees "stars"; he who *observes* the starry sky—the astronomer, sees planets, constellations, distant suns, nebulae. He lays the foundations of a science of astronomy.

Knowledge of nature apart from observation is impossible; that is, first hand knowledge is. The opening sentence of Lord Bacon's *Novum Organum* is the following aphorism: "Man, as the minister and interpreter of nature, does and understands as much as his observations on the order of nature, either with regard to things or the mind, permit him, and neither knows nor is capable of more." The absurd errors into which one may fall who formulates his ideas about nature in total disregard

of the observation of facts is strikingly illustrated by the case of Xenophanes, the Greek philosopher (born 556 B. C.). He taught that the stars are extinguished like lamps every morning and relighted every night; also that solar eclipses were caused by the extinction of the sun. With these ideas he held a professorship in the University of Athens for seventy years. St. Augustine stated that the peacock was so favored of God that its flesh would not decay after death! To be sure we may get information from books, but the original source of this information was someone's observation. "One may look and yet not see, because he does not think; or one may think and yet not know, because he does not look." [16] There is a vast difference between reading a description of beautiful scenery, however well illustrated, and traveling in the country itself to observe at first hand. One who sees the planet Saturn and its rings through a telescope for the first time realizes the difference between ideas obtained at first-hand and those obtained at second-hand. One who, having *seen* Saturn through a telescope, reads what the astronomer can tell us of that planet realizes the vast difference between seeing and observing. The first step in scientific method is observation.

Description.—The second step in scientific method is description. In fact, observation and description go hand in hand. One can hardly ob-

[16] Peabody, Francis G., *The Approach to the Social Question.* New York, 1909.

serve at all without, either consciously or unconsciously describing what he sees. But the essential thing is conscious description. The object of description is not only to have a record of what has been observed, but to aid our observation. We have before us, for example, a wild rose. If we lay it down before endeavoring to describe it, the chances are that we shall not be able to tell whether the rose had five or six petals, ten or many more stamens. We need only start to write the description in order to find how very inaccurate and hazy our real knowledge is. Everyone has cut open an apple, but almost no one can tell whether the little end of the seed points toward the stem-end or the blow-end of the apple—or neither. Says Ruskin: "The greatest thing a human being ever does in this world is to see something, and tell what he saw in a plain way." Most people cannot do this—at least not accurately.

Moreover, the ability to observe and describe accurately was only gradually acquired by the human race. Early accounts of natural phenomena are filled, not only with inaccurate, but with bizarre and even positively misleading and untruthful accounts of what purports to have been observed—the Scythian lamb, for example, goose-barnacles, and other imagined realities of early "science." It took men centuries to learn that they must sharply distinguish between what really did occur, and what they thought would or ought to occur—or what they wished to occur. There is in existence a published

map showing, *with pictures,* that the water of Niagara Falls flows over a dam made by beavers. The pictures show the beavers at work. Such was the criterion of truth and accuracy with men who, in all probability were not liars—who were not seeking to deceive, but who simply did not realize the importance of accurate observation and description. Every teacher of science knows that every class contains individuals who do not appreciate this; who have to learn, and that with difficulty, to be faithful to reality in what they describe in their laboratory notebooks as their observations. It is so easy and so common to put down what one thinks should be the fact, whether it squares with the actual observation or not, and this, strange as it may seem, in the interest of recording truth—with no thought of trying to deceive. One of the commonest questions asked of a science teacher by a beginning class in the laboratory is, "What *ought* I to observe?" "How many petals *ought* this flower to have," not how many *has* it? The ability to observe and to describe accurately is the only entrance to the straight and narrow way of scientific method.

When we recall, too, the well-known fact that early historians did not hesitate to incorporate into their narrative "verbatim" reports of speeches which they only imagined certain generals *might* have delivered on certain occasions, we learn that statements in very early books must be accepted as true to fact only when supported by abundant additional evidence.

Comparison.—The third step in scientific method is *comparison.* Before we can compare two objects we must first observe and describe both of them. The act of comparison serves to make our observation more accurate and complete, and discloses to us the difference or the similarity between two objects. One may observe and describe the bones in the arm of a man, the fore leg of a dog, and the wing of a hen, but by comparison he learns that they are composed of essentially the same (i. e., homologous) bones, differing only in shape and proportion.

Generalization.—Observation gives us an idea of a single object—this horse, this blue violet. Such an idea is a percept—the result of perception. But after one has observed many objects of a kind he is able to make, not fifty statements—one about each of fifty objects, but *one statement* that covers all the objects he has observed, namely, "All these violets are blue." The mental act implied by the ability to make this kind of a statement is a *generalization.* Such an idea is a *concept;* included in the concept are all the characteristics common to each of the individuals observed, and no others. By extension one may apply the generalization beyond the range of actual observation and, by inference, say, "*All* violets are blue." Whether our generalizations square with things as they are only further experience can tell. If, with such limited experience, one says to me, "I hold in my hand a violet," I say at once to myself, "It is blue." But observation reveals that it is yellow. I must then revise my con-

cept of violet. "All violets are either blue or yellow." In time, I see a white violet. Again I must revise my concept of violet. "All violets are either blue, yellow, or white." By this time, if I have a grain of wisdom so that I can profit by experience, I do not feel quite so sure about the range of color of violets. Perhaps some violets are red or pink. But again, if I am wise, I *do* know this: I know that my concepts are limited by my experience, and that I must hold myself ready at all times to revise my concepts in the light of additional evidence. This was the error of the rustic who said, when he beheld for the first time a giraffe, "There 'aint no such animal."

This is not an easy lesson to learn—this lesson that our concepts are generalizations limited by our experience, and that we may at any time be called upon to revise them in the light of adequate new evidence. This is what the physicists and chemists have had to do in the past thirty years with their concept "atom," the particle that "cannot" be cut. The first revision was, while retaining the name, to recognize that it was the better part of wisdom to say that an atom is a particle that *has not yet* been separated into simpler parts. With the discovery of radium and radioactivity we find that atoms are exceedingly complex, composed of many parts and, strange as it may seem, we now know more about fragments of atoms (the electrons) than we do about atoms themselves. The word atom has ceased to be a descriptive word; it is only a

convenient technical term, but universally recognized as, in reality, a misnomer. The history of science is full of such instances as this—the revision of our concepts as observation, description and comparison have increased or made more accurate our knowledge of the material world.

Formulating an Hypothesis.—But generalization is not explanation, and the human mind craves explanation. After thousands of stones and other heavy objects were observed to fall toward the ground when not supported, the generalization was made, "All unsupported objects fall to the ground." But inquiring minds pressed the question, "Why do they fall?" As Peabody has so well put it, the great man of science wishes not only to see the facts but to see into facts; not only to have sight, but to have insight. And so, upon the basis of what he has observed and generalized he begins to think out what seems to be a rational explanation of the facts. "All heavy bodies fall *because* the earth attracts them." Why this suggestion? Well no one ever saw a falling body pushed from above. True, no one ever *saw* a falling body pulled by any visible means, but it has hitherto seemed most rational and natural to conceive of the falling as due to an attraction, hence the *hypothesis* of gravitation, the earth's attraction. Finally, the great intellect appeared—Sir Isaac Newton, who worked out the mathematical formula for the *law* governing falling bodies: "Every particle of matter in the universe *attracts* every other particle of matter, directly as their

masses and inversely as the square root of the distance between them." Nobody knows this as a matter of observation; nobody ever saw it; it is solely a matter of inference, but the inference is based upon observation. We call it a hypothesis. The word means, *etymologically,* a guess; but only etymologically. A hypothesis is as far from a guess as the east is from the west, for a guess, as the word is commonly used, means a haphazard opinion, arrived at without much if any reference to the facts in the case. We "guess" how many beans one holds in his closed hand—a quite different act from framing a hypothesis.

One who really understands what a hypothesis is, as contrasted to a guess, can hardly believe his senses when a man of education and influence shows either an utter ignorance of the difference, or else wilfully seeks to confuse others and misrepresent the work of the most gifted, and earnest, and reverent seekers after truth the world has yet produced. Such a spectacle the public in America has recently witnessed. How important it is that we know *how* to think about scientific matters, especially when they are publicly and grossly misrepresented, and in connection with man's most precious possession—his religion. If we know *how* to think, we may have no fear of the results of our thinking.

Testing the Hypothesis.—But what is the attitude of the scientist toward a hypothesis? Does he imagine that when he has made an inference he has necessarily arrived at the truth? Not at all. As

soon as a hypothesis is formulated the scientist begins at once to question its validity. He puts it to all manner of crucial tests. If it is true, he says, such and such other things ought to be true—such and such things ought to result under certain circumstances. Let us see if things really do happen as they would *if* the hypothesis is true. And so he proceeds, by even more careful observation and experiments, to test the hypothesis. He becomes toward the hypothesis its greatest enemy. He must disregard his likes and dislikes, his personal preferences, his preconceived ideas and prejudices. What he wants to know is the truth, regardless of whither it leads or of what cherished idols of intellect it overthrows.

The hypothesis thus becomes mainly a guide to further investigation of the problem. How silly it is, therefore, to talk of teachers of science presenting a hypothesis "as true." It is a contradiction of terms. A hypothesis is what someone, on reasonable evidence, supposes *may* be true, as an explanation of what has been observed. When thoroughly put to the test the hypothesis may be found *not* to square with the facts. What then? Why, it must be rejected, and another hypothesis framed and tested. The second hypothesis points the way to a new line of experiment and observation. New evidence is accumulated, and so the process is repeated —over and over again, if necessary, until, happily a hypothesis is found that *seems* to agree with the facts. Still it is held in doubt. The scientist must

be skeptical about it until a mass of accumulated evidence compells him to regard the hypothesis as *probably* correct.

When a hypothesis has been thoroughly tested, especially if it is tested by numerous investigators, and no facts are found at variance with what must be true if the hypothesis is correct, then the hypothesis becomes known as a *theory*. By the studies of other mathematicians, and in particular of the noted French mathematician, Laplace, the Newtonian hypothesis was worked out in greater detail and early doubts about it were removed, until it finally came to be known as the *theory* of gravitation. But even a theory is never confused with fact—that is, by a competent scientist. Many men have given the best of their lives to testing the validity of some theory.

This is the way science advances: observation, description, comparison, generalization, hypothesis, theory. Then more observation with special reference to the hypothesis or theory. This is known as *the method of the working hypothesis;* it is also known as the method of *multiple hypotheses*. It is the most powerful intellectual tool for the discovery of truth known to man. It is the only known rational procedure for arriving at a correct understanding or explanation of the material world.

The pathway of science is strewn with abandoned hypotheses; first, the nature-myths as explanations; then "gods" as secondary causes; demons and witches as causes, for example, of disease or other

catastrophe; then flimsy superstitions as to the causes of events, such as thirteen at table, or breaking a mirror causing a death, or raising an umbrella in the house bringing trouble—their number is legion; then irrational inferences, such as the supposed influence of the moon on the weather, or eclipses as the cause of wars and famine. It is the history of the human intellect slowly and painfully progressing through the ages to that remarkable achievement—the method of multiple hypotheses. And then follows the history of rejected rational hypothesis: the hypothesis of a flat earth, of the earth at the center of our planetary system, of heat as a substance (caloric), of spontaneous generation, of atoms as indivisible; the numerous hypotheses as to the origin of the diversity of animal and plant life on the earth; the nebular hypotheses as formulated by Laplace and others.

Among hypotheses that have attained the rank of a theory may be mentioned the Ptolemaic and the Copernican theories of the solar system, the theory of biogenesis, the glacial theory, the atomic theory, the Darwinian theory of organic evolution, the theory of universal evolution. Of these, when put to the test, the Ptolemaic theory has been disproved and so rejected; the atomic theory has been profoundly modified, though confirmed in certain details; it is still being most severely tested. The Copernican theory, the theory of biogenesis, the glacial theory, and the theory of universal evolution are now regarded as sufficiently confirmed to be gen-

erally accepted as facts. The Darwinian theory is no longer held by modern biologists in the precise form in which it was formulated by either Darwin or its "co-discoverer" Wallace, but is still regarded in its modified form by substantially every working biologist as one of the theories most likely to lead in the direction of truth concerning the method of the origin of species. A large proportion of the biological study of today is in the nature of testing the Darwinian theory or the modern form of it. Organic evolution is accepted as a fact; it is only the *method* of evolution concerning which there is doubt and difference of opinion.

It has recently been affirmed by a well-known American, who has devoted most of his life to politics and oratory, not to science, that "Neither Darwin nor his supporters have been able to find a fact in the universe to support their hypothesis." Anyone acquainted with the writings of Darwin and other students of organic nature fairly gasps to read such a statement from a man who has been alive and endowed with brains during the past fifty years. It is common knowledge among scientific men that Laplace made and recorded observations for eighteen years before he announced to the world his nebular hypothesis. We have Wallace's own word for it that he collected and studied nearly 9,000 species of animals and plants before he began to speculate on the *causes* that might have brought about the present great multiplicity of species. Charles Darwin collected and analyzed facts for

twenty years before he felt even willing to begin to write his *Origin of Species.* And even then he did not feel ready to write, but prepared his manuscript only at the earnest solicitation of his scientific friends because, in their judgment, the time seemed ripe for the theory to be announced. Who, knowing these facts, can honestly say that the theory of natural selection as the cause of the origin of species (Darwin's theory) has not a fact in the universe to support it? Who that is not acquainted with this chapter in the history of science would be rash enough, or so unmindful of truth as to venture to make any assertion whatever on the subject?

It is of particular interest to see how carefully Darwin collected and pondered all facts that might have any bearing on his theory—those that seemed opposed to it as well as those that seemed to confirm it. In a letter written in March, 1855, to Mr. Fox,[17] Darwin writes:

"I forget whether I ever told you what the object of my present work is—it is to view all facts that I can master . . . in Natural History to see how far they favor *or are opposed* to the notion that wild species are mutable or immutable: *I mean with my utmost power to give all arguments and facts on both sides.*" [18]

In 1837 he wrote in his pocket note-book: "In July opened first note-book on Transmutation of Species. Had been struck from about the month

[17] Darwin, F. *Life and Letters of Charles Darwin,* 1:409.
[18] The italics in the quotation are the author's.

of previous March on character of South American fossils, and species of Gallapagos Archipelago. *These facts* (especially latter) origin of all my views."

And again, in a letter to Joseph Hooker in 1844, he writes: "I have read heaps of agricultural and horticultural books, and *have never* ceased collecting facts." [19] It is further enlightening, as a study in scientific method, to learn that the analysis of the facts so laboriously collected, caused Darwin himself to change his views in favor of the theory of evolution by natural selection. In 1845 he wrote to L. Jenyns: "I have continued steadily reading and *collecting facts* . . . on the question of what are species. I have a grand body of facts, and I think I can draw some sound conclusions. The general conclusions at which I have slowly been driven *from a directly opposite conviction,* is that species are mutable, and that allied species are co-descendants from common stocks."

In his *Autobiography* Darwin says: "Never did I intermit collecting facts bearing on the origin of species; and I could sometimes do this when I could do nothing else from illness." Later on in the *Autobiography* he speaks of thinking over the facts and says, "The subject haunted me." Finally he speaks of the inspiration that came to him one day while reading *Malthus on Population*—the clear conception of struggle for existence and natural selection, and says, "I had at last got a theory *by which to*

[19] L. c., p. 384.

work," adding, "I can remember the very spot in the road, whilst in my carriage, where to my joy the solution occurred to me." This was in October, 1838, fifteen months after he had begun his inquiry. After that he collected his facts in two groups—those that tended to prove, and those that tended to disprove his "theory."

Darwin's writings are full of discussions of what he called "difficulties" which seemed to stand in the way of his theory. No one was more eager than he to give full consideration to these difficulties. No one was as keen as he to realize that there were very serious difficulties. To his own mind his theory was never a foregone conclusion.

Chapter VI of the first volume of the *Origin of Species* (over 50 pages) is entitled "Difficulties of the Theory," and Darwin speaks of a "crowd of difficulties . . . some of them are so serious that to this day I can hardly reflect on them without being in some degree staggered." Among the difficulties he specifically mentions the absence of "connecting links" or transitional forms between species. This has been one of the greatest stumbling blocks to opponents—especially those who have not given twenty years (as Darwin did) often not twenty hours, to considering all sides of this difficulty in detail, in the light, not of prejudices, but of facts. After thoroughly analyzing these difficulties Darwin shows that some of them are "very apparent, and those that are real are not, I think, fatal to the theory."

And he definitely states that his theory is presented not as a fact—not even as a *probability,* but only as a possibility; that is, as a rational and reasonable explanation (a theory) of the method of the origin of species.[20] "The imperfect evidence," says Darwin, "of the continuousness of the organic series (i. e., the scarcity of intermediate form between species), which, we shall immediately see, is required on our theory, is against it; and is the most weighty objection. The evidence, however, even on this point, as far as it goes, is favorable; and considering the imperfection of our knowledge, especially with respect to past ages, it would be surprising if evidence drawn from such sources were not also imperfect." [21] In the above paragraphs we obtain a condensed but clear insight into the working of one of the world's greatest intellects in the process of formulating and then putting to severe tests, one of the greatest working hypotheses ever formulated.[22] We look almost in vain in the writings of the opponents of evolution for such self-criticism,

[20] *The Foundations of the Origin of Species—Essay of* 1844, Cambridge, 1909, p. 132.

This is not the place to try to expound Darwin's theory, for the purpose of the present little book is not to win adherents to Darwinism nor to evolution in its broader aspects, but only to point out *how* one should think about evolution, in its relation to theology and religion. The essence of Darwinism is stated in the full title of his great book: *The Origin of Species by Natural Selection, or the Preservation of Favored Races in the Struggle for Life.*

[21] L. C., p. 134.

[22] Huxley called Darwin's *Origin of Species* "the most potent instrument for the extension of the realm of natural knowledge which has come into men's hands since the publication of Newton's *Principia.*"

such open-minded candor, such frank facing of all sides of the question, such a desire to know the truth wherever it might lead, such keen analysis of the problem and its difficulties, such a prolonged and careful study of it. In fact, most of the modern opponents of the theory of evolution have never studied any of the *facts* on which the theory is based. They have never been in the laboratory and field as investigators of plant and animal life. What studying of the subject they have done has been confined to reading literature about it and then deciding what opinion they *preferred*. Like Omar Khayyam in the Rubaiyat they

> "did eagerly frequent
> Doctor and Saint, and heard great Argument
> About it and about, but evermore
> Came out by that same Door as in I went."

The writer once heard a man who had been the pastor of a church all his professional life declare in his pulpit that he had given several years to studying evolution. To have given several years "to studying evolution," in the sense in which Darwin and other students of biology would use the phrase, simply would not have been possible while discharging the duties of a large city pastorate. We must clearly distinguish between deciding which of two opinions makes the strongest appeal to us, and analyzing, at first-hand, the *facts* which supply the only solid foundation for any opinion at all.

The Method of the Working Hypothesis Applied to the Question of Immortality.—To understand

the method of the working hypothesis in the endeavor to explain the riddles of the universe is to recognize that there are possible more than two attitudes toward a question that cannot be definitely proved. Take, for example, the question of immortality. "If a man die shall he live again?" Happy are they for whom this is not a question; who feel that they possess, in Christian literature and in their own experience, satisfactory evidence that immortality is a fact. What intellectual rest this brings! What religious peace! But there are multitudes of others, just as serious, just as devout, eagerly wishing for this assurance who, if they are intellectually honest, do not feel that the evidence is sufficient in amount or kind to enable them to accept immortality as an assured fact. Many, perhaps most, of this group do not realize that there is a third position they may take, and in which they may find genuine satisfaction, or at least more satisfaction than in agnosticism. "I must either accept immortality as an assured fact, or reject it *in toto,*" they believe. But the working hypothesis offers a middle ground, and one who understands this may say: "I do not feel that the evidence is sufficient to enable me to accept immortality as a demonstrated fact; but there is, on the other hand, not sufficient evidence to amount to a disproof. Therefore, while I cannot accept, I need not reject the teaching of immortality. I will accept it as a working hypothesis, and order my life and my thinking accordingly. I will accept it as true *until* someone disproves it."

And there has never been produced any more evidence nor any more weighty argument against immortality than for it. Just as science has made wonderful progress on the basis of working hypotheses, so may one progress in a satisfying religious life by accepting immortality as a working hypothesis—by accepting it *as true* until it is disproved.

FACT AND HYPOTHESIS IN EVOLUTION

IN preceding paragraphs we have tried to make it clear that evolution means that the present order of the universe has come about by a series of gradual changes occurring in orderly sequence over vast stretches of time. The configuration of the universe at any given point in time is regarded as the necessary result or outcome of its configuration at the immediately preceding moment. Nature is uniform in her methods throughout the ages. Moreover, the process is a continuing one; there is no *end* result. Evolution is in progress today as truly as at any time in the past; it will continue until all the energy in the universe is transformed into heat-energy, and the heat uniformly distributed—if, indeed, such a state of affairs is ever likely to occur. Modern science applies the conception of evolution to the entire realm of matter, and even to the intellectual, social, moral, and religious realms. There is no stand-still

anywhere. If we doubt this we have only to look about us; planets, stars, the surface and interior of the earth, plants and animals, knowledge, intercourse, conduct, worship—change while we observe them. "The good old times" are perpetually coming and going.

Every scientist—which is the same as saying everyone acquainted with the facts at first-hand—accepts evolution as a fact. To deny it is equivalent to confessing either lack of understanding as to what the word evolution means, or to confess lack of first-hand acquaintance with the evidence bearing on the case. The conception of evolution was the outcome of endeavoring to describe in detail the sequence of events in the history of the universe. The more carefully men observed and the more accurately they described the more clearly they saw that the process was one of evolution; that order is not only heaven's first law, but also the law of the material universe.

But when we come to methods and processes, then we begin to pass from fact to theory—from what has become clear as a bell, to the realm of doubt and difficulty. Planets and suns evolved; of this we feel sure. But how? Just what were the steps and their sequence? More than one view appears probable or possible. Which is correct? Then we apply the method of multiple hypotheses.

That all things now living were derived from parents, of this we feel certain. And that the plants

and animals of preceding geological ages were different from those now living—of this we *are* certain, for we find their remains in the rocks and they are unlike existing plants and animals in details, though closely similar in certain broad fundamental respects. Just what were the changes, step by step? Now the work and the pleasure and the revelation begin. This is science. Observe and describe and think; think and observe and describe. "Raisonné, raisonné, raisonné longtemps; et toujour raisonné," said a noted French scientist.

This is what Darwin did for twenty years. As a result he produced his epoch-making books. His theory was the theory that the facts of biology spell evolution just as clearly as do the facts of astronomy, or geology, or philology, and in particular that the method of evolution was the preservation of those organisms best fitted to survive, during a process of struggle for existence, and the extermination of the unfit. To this process Herbert Spencer gave the name, "Natural selection." Some think of it as "natural rejection."

Let us not forget that natural selection was proposed as a working hypothesis—as the most probable "explanation" (that is, sequence of events) suggested by the observed facts Then the hypothesis was put to the test. Not even the golden rule has been more thoroughly tested. After repeated confirmation the hypothesis assumed the rank of a theory, and such it has been ever since. No com-

petent scientist ever taught it or held it "as true." [23] In the light of recent investigations the theory as Darwin conceived it has been considerably modified. Even Wallace's Darwinism was not precisely the same as Darwin's Darwinism; but the theory has been so modified in the light of new evidence that it may be properly designated by the name "neo-Darwinism"—the new Darwinism. As Professor Bateson said, in his Toronto address in 1921, that organic evolution is a fact, we are certain; as to the exact method of organic evolution we are still more or less in doubt.

The Value of a Fruitful Hypothesis

Much of the scientific output in biology and related sciences since 1859, the date of the publication of Darwin's *Origin of Species,* has been the result of studies made to test the truth or falsity of Darwin's theory or some portion of it, or to solve problems suggested by Darwin's work or growing logi-

[23] Bills have recently been introduced into several State legislatures making it unlawful to teach "as true" the Darwinian theory as applied to man. Severe penalties, including loss of position and salary, are provided for those who break this law. No one competent to teach science ever taught any *theory* "as true." As soon as it is positively known to be true it ceases to be theory and becomes *fact.* What a theory does is to help us to think, and to tell us what observations ought to be made next.

cally out of it. The expansion of our knowledge of biology during those fifty years has been greater than in any previous 500 years, and the blessings to humanity, intellectual, spiritual, and physical, are quite beyond words to express.

Contrast the reasonableness and fruitfulness of the evolution theory with one of the products of the ripest scholarship in theology, endeavoring to solve the problems of science by other than the scientific method. Dr. John Lightfoot, vice-Chancellor of Cambridge University, England, in the seventeenth century published a book in which he asserted that, "The earth and man were created by the Trinity on October 23, 4004 B. C., at nine o'clock in the morning!" At what part of the world it was 9 a. m. when the manufacture of the earth was thus completed the writer does not state.[24] If men could find intellectual satisfaction in such pronouncements as this there would never be any science, for science is

[24] A recent manifestation of this type of mind and this point of view is the resolution which, according to an Associated Press report of May 21, 1924, from San Antonio, Texas (*N. Y. Times,* May 22, 1924), was adopted by the General Assembly of the Presbyterian Church in session at that place and date. The resolution is reported to read, in part, as follows:

"The Church remains at this time sincerely convinced that the Scriptures, as truly and authoritatively expounded in our Confession of Faith, teach that Adam and Eve were created, body and soul, by immediate acts of Almighty Power, thereby preserving a perfect (*sic!*) race, and that Adam's body was directly fashioned by Almighty God, without any natural animal parentage of any kind, out of matter previously created from nothing, and that any doctrine at variance therewith is a dangerous error . . ." It is difficult to believe that men reared in the intellectual environment of the past fifty years in the United States, can seriously and sincerely accept such teaching, yet such appears to be the case.

born of curiosity ripened into interest. Granted that the world was made by the Trinity, at whatever day and hour, the fact remains that there are multitudes of men with a scientific type of mind who wish to know *how*—by what processes and by what sequence of events, the Creator wrought. This desire to know, to describe, to understand the details is the fountainhead of all scientific research; its result is our body of scientific knowledge. We may say that God made electricity, but to be satisfied with that statement would never give us the electric light, nor the telephone, nor radio.

But science is not advanced by haphazard observing; it progresses by systematic investigations with a view of ascertaining whether a certain well-founded supposition (the working hypothesis) is *or is not* true. The value of the hypothesis does not depend on whether it is or is not confirmed when put to the test, but on whether it has been fruitful in stimulating and guiding further observations. When one hypothesis is disproved another emerges, and so science has a perennial freshness and challenge. The true scientist is indifferent as to whether the Darwinian hypothesis is or is not true. It has already proved its value as the most powerful stimulus to investigation in the entire history of biology. The results of this study have the highest value, not alone for science, but also for theology and religion, for they have been the cause of the most thorough restudy of the foundations of Christianity, and have given us a conception of Deity which is as much of

an improvement on the old infinite-superman conception, as that was over the ghost worship of more primitive religions. We should not lose sight of the fact that right ideas of the world are essential to right ideas of God.

SCIENCE AND THE BIBLE

THE proper interpretation of the Bible in the light of modern knowledge is a large question and it would be folly to presume to discuss it adequately in a few paragraphs. There are various books, easy to obtain, which treat of the subject from various angles from the standpoint of religion and theology, and the reader who wishes to follow this subject more extensively is referred to them.

Not to attempt the impossible, and try to discuss this question fully, it may be said that one who is not willing to have the Bible interpreted by the same standards of literary criticism as we apply to other literature is not in the proper attitude of mind to enter into a discussion of the relation between science and the bible. This is only another way of saying that the relation of science and religion cannot be discussed by one who is still basing his opinions on superstition, or tradition, or prejudice. For such a one there is really nothing to dis-

cuss. Here, as throughout, an open mind is absolutely essential.

In the first place, no one can possibly hope to arrive at a correct estimate of the Bible and a correct interpretation of it who is ignorant, for example, of its history; who does not know that for centuries no one has seen an original manuscript of the text, that for centuries the only method of multiplying copies was by handwriting with all the opportunities this offered for the introduction of errors and additions, or the dropping out or insertion of words and phrases, either wilfully or by accident or carelessness; who does not know that the biblical texts we now possess have come down to us by translation and retranslation with inevitable introduction of changes and errors by the translators;[25] who is not familiar with the common custom of copyists of adding marginal comments which in subsequent copyings became incorporated as an integral part of the text; who is not somewhat familiar with the folklore and legends of different ancient peoples so that he may detect these or versions of them in the literature of antiquity; who does not know that high standards of accuracy as to fact in the writing of history and science are comparatively modern, so that ancient writings are to be judged in accordance with the general conceptions and standards of

[25] One of the arguments advanced by early theologians against the teaching that the earth is a sphere, was the statement in Isaiah xl., 22, and Job xxxviii., 38, and yet it is now known that both of these passages were mistranslated in the Septuagint version of the Bible. (Lecky, *Rationalism in Europe*, 1:279).

the age in which they were written, and not by modern standards. These are only a few illustrations of the circumstances that make a literary criticism of the Bible an absolute necessity if we are sincerely desirous of arriving at a true understanding of the book. We see that the present biblical text itself is a product of evolution, that it has come down to us through a multitude of gradual changes and survivals.

The question of the correct interpretation of the Bible is a very old question and has had many vicissitudes. For our purpose here it is significant to note that the history of biblical criticism discloses what, from the standpoint of scientific method, is a very persistent error, namely, the interpretation of every statement as a bald statement of fact. This method of criticism we do not apply to any other literature, but recognize the fact that authors may employ figures of speech, may drive home a truth by the use of a folk-story or fairy tale, or may embellish their narrative with original or quoted poetry. This latter and reasonable method of interpretation was applied to the Christian Scriptures by some of the early church fathers. For example, St. Gregory of Nyssa, St. Augustine, the venerable Bede, and others, "revolted against the conception of an actual creation of the universe by the hands and fingers of a Supreme Being . . . but the more material conceptions prevailed, and we find these taking shape not only in the sculptures and mosaics and stained glass of cathedrals, and in the illumina-

tion of missals and psalters, but later, at the close of the Middle Ages, in the pictured Bibles and in general literature." [26] Such conceptions also became a part of the very warp and woof of popular thought by their incorporation into the widely read poetry of Caedmon, Milton, and other poets. They were also taught by Luther and Calvin and their followers with all the weight of authority of great names.

It is important for our purpose to note how insidiously or unconsciously ideas often become a part of one's mental stock in trade. One who, from childhood is brought up surrounded by pictures on church windows, in illustrated bibles, Sunday-school lesson papers and elsewhere depicting various ideas about God is almost certain to find those ideas insensibly incorporated into his own thinking or coloring his conceptions. As a result, it often becomes difficult in maturer years to substitute for the earlier and cruder notions more rational conceptions. For example, as a result of such pictures, many of us, through a large part of our lives, have visualized God as a sort of super-man, with a long flowing beard, hand upraised, and seated on a throne precariously supported in the clouds. With this vivid picture in mind how easy it becomes (unconsciously even) to regard God as Augustine did, as "in his heaven," ruling the world from without, rather than as omnipresent in the universe.

[26] White, Andrew D., *A History of the Warfare of Science with Theology in Christendom,* 1:3, 1908.

Many devoutly religious people also hold ideas which they think are taught in the Bible, but which were, in reality, first taught in later church literature, especially that embodying the transactions of church councils. Thus the teaching of the resurrection of the material bodies of men, as affirmed in the Apostles' Creed, contrary to the teaching of St. Paul,[27] is believed to be the teaching of scriptures by many who are also ignorant that the so-called "Apostles" Creed was not formulated for several centuries after the death of all the apostles.

The lesson to be learned by those who wish to know *how* to think about the relation between science and religion is that, in matters where correct ideas are of vital importance, one ought carefully to analyze the probable sources of his ideas and beliefs in order to know whether they have a rational basis, and whether they are, in reality, what one actually does think and believe. After such an analysis one often finds that what he thought he thought means that he had not really *thought* at all—that he had only been entertaining an idea whose validity he had never examined.

The history of Biblical interpretation discloses, among other things, another very persistent error. As early as 1620 Francis Bacon wrote: "The apotheosis of error is the greatest error of all, and when folly is worshipped, it is, as it were, a plague spot upon the understanding. Yet some of the moderns

[27] "So also is the resurrection of the dead. . . . It is sown a natural body; it is raised a spiritual body." (1 Corinthians xvi., 42, and 44.)

have indulged this folly with such consummate inconsiderateness, that they have endeavored to build a system of natural philosophy on the first chapter of Genesis, the book of Job, and other parts of scripture; seeking thus the dead among the living." [28] No attempt should be made here to discuss the question as to whether the Bible is to be accepted as a text-book of natural science. In preceding paragraphs we have seen into what follies men have been led by regarding the Bible in this way. Certainly there is nothing in the Bible itself to lead one to infer that it was ever intended as a treatise on science.

We are told that the scriptures are able to make us "wise unto salvation," but nowhere that they are able to make us wise unto astronomy, or geology, or biology. To hold that the Bible is inspired does not imply that every word in it, including the Psalms and the Song of Solomon, is a record of fact. He who proposes to support such a thesis will soon find himself covered with embarrassment, especially if he endeavors to convince a man who has encircled the globe. All scripture, says Timothy, "is profitable for doctrine, for reproof, for correction, for instruction in righteousness." This is the function of all bibles, and the Bible of Christianity contains the priceless account of the religious aspiration and accomplishment of the race that preserved for all

[28] *Novum Organum*, Aphorism LXV. By the phrase, "the dead among the living," Bacon refers to the use of these words in the Bible—temporal, material interests being the "dead," only spiritual interests being considered "living."

mankind and handed down to us the wonderful conception of one God.[29] There are statements in the Bible that flatly contradict the daily experiences of every one of us, but this does not mean that science is irreligious, or atheistic, or erroneous; nor does it mean that the scriptures are not true. "To say that they are not true is as if one should say that a flower or a tree or a planet is not true; to scoff at them is to scoff at the law of the universe. In welding together in noble form, whether in the book of Genesis, or in the Psalms, or in the book of Job, or elsewhere, the great conceptions of men active under an earlier inspiration, whether in Egypt, or Chaldea, or India, or Persia, the compilers of our sacred books have given to humanity a possession ever becoming more and more precious; and modern science, in substituting a new heaven and a new earth for the old—the reign of law for the reign of caprice, and the idea of evolution for that of creation—has added and is steadily adding a new revelation divinely inspired." [30]

[29] The preservation of monotheism, which was assured by the migration of Abram from Mesopotamia, gives to that migration an historical importance comparable to that of the discovery of America by Columbus.

[30] White, Andrew D., *A History of the Warfare of Science with Theology*, etc., 1:23-24, 1908.

EVOLUTION AND RELIGION

WHAT has evolution to do with religion? In a sense, nothing. Science has to do with the so-called secondary causes; religion has to do with man's relation to the Great First Cause—Myself and God. If one wishes to define evolution or even Darwinism as the description of "how God works" the scientist has no objection. The problems, and method, and purpose of the scientist would not be affected in the least by stating it that way. In fact, that is precisely how the problem is conceived by many scientists, as well as by many theologians and religious leaders.[31] The cause of the antagonism that has manifested itself between religion and science in Christendom has been due more to the prevalent conception of the nature of God and his relation to the material universe, than to the results of scientific research, and this conception is not one that has always been held, but was introduced and made popular by Augustine. This has been clearly stated by John Fiske in his valuable little book, *The Idea of God*. The earlier church fathers, Clement of Alexandria, his pupil Origen, and Athanasius, conceived of God, not as absent from the world and governing it as an Emperor governs a colony, but

[31] See, for example, Milliken, Robert A., *A Scientist confesses His Faith*, and Fosdick, Harry Emerson, *Evolution and Mr. Bryan*. Both these pamphlets are published by The American Institute of Sacred Literature, Hyde Park, Chicago, Ill.

as immanent in the world, as the "soul" of man is conceived as being immanent in the body. To them God really was omnipresent as well as omnipotent. From this point of view the term "secondary causes" is a misnomer; God is the direct cause of everything. He does not set the world going and then leave it, only to return at intervals to interfere with the orderly progress of events. If this idea of immanance had become the dominant conception of God in the Christian Church, antagonism to the results of scientific research could hardly have developed, for it would always have been understood that scientific research was only the endeavor to describe accurately and in detail how God *works* (not "worked").

But, as the wonderfully organized Roman empire was passing away, there emerged what is now the Roman branch of the Christian church, modeled in its polity after the Roman state and under the teaching and weighty authority of Augustine, developing a conception of God in harmony therewith. God was the Ruler enthroned outside the world, possessing all the human mental characteristics, and interfering with the course of events on earth chiefly when he was angry with men, or when he yielded to their pleadings to interfere. The watchmaker had made the watch; he interfered with its running only as opportunity offered or occasion might require. Also he wrought without means. God "spake," and it was so. How? Some said it were impious to inquire how.

Holding such a conception of the nature of God as this, theology might have a quarrel with all science, and in fact this was the case. We can hardly believe now that theologians ever quarreled with Newton and his law of universal gravitation as irreligious, but he was vigorously opposed by his ecclesiastical contemporaries and accused of trying to substitute gravitation for Providence. Even the philosopher Leibnitz attacked the law of universal gravitation "as subversive of natural, and inferentially of revealed religion." The antagonism is ancient. In 1620 Bacon called attention to the fact that natural philosophy (meaning science) "has, in every age, met with a troublesome and difficult opponent: I mean superstition, and a blind and immoderate zeal for religion." Nor has the conflict by any means been confined to Christianity. Not even Socrates escaped, for he was accused by his contemporaries of banishing Jupiter from the heavens by giving a natural or "scientific" explanation of thunder as due to concussion of the air—the modern explanation. In still later days Robespierre, attempting to introduce lightning rods into France, was accused of trying to thwart the will of Providence! "In short," says Lord Bacon, "you may find all access to any species of philosophy, however pure, intercepted by the ignorance of divines. . . . But," he continues, "anyone who considers the subject will find natural philosophy to be, after the Word of God, the surest remedy against superstition, and the most approved support of faith. She

is, therefore, rightly bestowed upon Religion as a most faithful attendant, for the one exhibits the will and the other the power of God."

But practically every scientific truth that was opposed by theologians and organized religion prior to Darwin became, in time, a part of the mental stock in trade of every educated person in the church or out. Nobody any longer denied that the earth is round, that it revolves about the sun, or that fossils are the actual remains of ancient plants and animals.[32] The persecution of Lyell (whose *Principles of Geology* did not square with the then current interpretation of Genesis) while real was comparatively mild. The older outposts were abandoned by the adversaries of science, and the protagonists of religion confined their attacks almost entirely, not to science as a whole, nor even to evolution as a whole, but to the particular theory proposed by Darwin to explain the method of the evolution of man and other animals, and plants.

It is of particular interest in this connection to note that Darwin himself did not by any means exclude the notion of a Creator from his own think-

[32] The practically universal acceptance of the *theory* of the earth's rotation as a *fact* is an interesting point in the history of science, for it is not a fact, in the sense that it has or can be directly observed, but only an inference from other facts. It has never been directly experienced by any of our senses, and never can be. Indeed, if we were directly sensible of the earth's motion, as we are of the motion of a train or boat, pendulum clocks would be well-nigh useless and the measurement of time and distance would be exceedingly difficult if not quite impossible. Even the classic experiment of Foucault's pendulum does not give us any immediate experience of axial rotation, but only additional evidence in support of the theory.

ing. To his mind evolution and God were not mutually exclusive ideas. In Chapter VI of the *Origin of Species,* he speaks of the human eye as "a living optical instrument . . . as superior to one of glass, as the works of *the Creator* are to those of man." Denying that he was endeavoring to substitute a mechanical principle for God (as Newton was accused of doing), Darwin writes (Chapter IV of the *Origin*), "It has been said that I speak of natural selection as an active power or Deity; but who objects to an author speaking of the attraction of gravitation as ruling the movements of the planets. Everyone knows what is meant and is implied by such metaphorical expressions; and they are almost necessary for brevity. So again it is difficult to avoid personifying the word Nature; but I mean by Nature, only the aggregate action and product of many natural laws, and by laws the sequence of events as ascertained by us." The concluding sentence of the *Origin of Species* is as follows: "There is a grandeur in this view of life, with its several powers, having been originally breathed by *the Creator* into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved." Certainly no honest reader of this sentence could accuse its author of atheism, or of trying to substitute law or force or anything else for God.

SUMMARY

AS we have already stated, this little book was not written for the purpose of proving the truth or falsity of evolution, nor of the Darwinian theory of the origin of species but, as the title implies, for the purpose of endeavoring to point out *how* one should think on the question of the supposed antagonism between science and religion. If the author has succeeded in his purpose the reader has recognized that there may be antagonism between the methods and results of science and a particular brand of theology (the Augustinian), but not between science and religion, *for there can never be any conflict between two truths.* We have endeavored to point out that the aims and methods of science are quite different than those of religion. Science deals with the material world and with origins; religion with the life of the spirit in relation to God, and with destinies. What does religion care about the origin of man? That does not affect his nature as we know it, his duties, his powers, his relation to God, nor his future.

From the dawn of history the study of science has profoundly affected our idea of God. It was the study of nature that banished the primitive polytheism that postulated a god for every kind of event. It was the study of geology that showed

us what vast stretches of time God may employ to accomplish results. It was the study of astronomy that completely revolutionized our conception of actual distances and thus our conception of the unlimited and the eternal. The newer concept of the infinitely small, revealed by bacteriology, and later by physics and chemistry in the phenomena of radioactivity, still further enlarged our conception of the range of infinity, with perfection in the infinitely small as well as in the infinitely great, and thus our conception of the Power behind it all. And the most recent discoveries in radio have not only revealed an entire new order of phenomena, but have even more truly revealed to us how little we really do know about the "forces" of nature, and therefore how cautiously we ought to proceed in trying to define (set limits to) God. People who have learned to control epidemics of infectious disease by modern methods of sanitation cannot help having a different conception of God than people who knew nothing of germs, and believed that epidemics were only displays of temper on the part of Deity, and were to be dispelled merely by repeating prayers. Whatever our theories may be, the conception of God most prevalent today has been profoundly molded and ennobled by the results of scientific research. Religion is indebted to science quite as much as science is indebted to religion.[33] If the church expects to gain and hold the allegiance of thinking men, especially young men, it must never lose sight of this fact.

But still more definitely we have endeavored to show that if one hopes ever to arrive at correct conclusions as to the relation between religion and science—if he ever hopes to know that he may fully accept the teachings of modern science and at the same time retain all that is essential and right in the Christian religion, one must think without prejudice; he must really *want to know* the truth, where ever it leads; he must refuse to indulge in unworthy personalities in the mistaken notion that imputing low motives to an opponent is equivalent to argument.

Further, one must recognize that all ideas—those of religion as well as those of science—have had a long history, and have undergone many revisions from the time when men began to think until the present age, and it is hopeless to expect to think correctly unless one is more or less familiar with this historic background of religion and science.

If one wishes to think straight, he must understand what is known as the method of science; he must know *how* to think, and must clearly understand the difference between knowledge—the end result — and hypotheses — the stepping stones to knowledge. If one knows *how* to think he need have little worry about what to think.

[33] The indebtedness is not all one-sided, though it may seem so to a certain type of mind. Of what avail for human needs would be a knowledge of the modern methods of sanitation and hospital practice in a society whose religion had never enforced the lesson of the good Samaritan and social service? How ineffective would be much of our efforts at social relief if we were ignorant of the principles of modern hygiene!

Finally, to whatever extent we seek for guidance from others in matters of both knowledge and faith, let us never lose sight of the wisdom of leaving it to the theologians to find out where we are going to, but to the evolutionists to find out where we came from.

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